Technical, Management and Cost Panel Expectations on SMA-Related Program Requirements for NASA Class C and Class D Payloads

Revised 14 April 2016

Contents

Introduction

Purpose of this Presentation

This document contains guidelines for proposers on proposal content for Class C and Class D payloads.

Many Earth and Space Science mission proposals to NASA go through a Technical, Management, and Cost (TMC) evaluation. This document is intended to assist proposers in understanding some of the expectations of the TMC Evaluation Panel.

Because there are many Announcement of Opportunity (AO) and Program Element Appendix (PEA) requirements that are common to Class C, and D, including CubeSats, this presentation focuses specifically on providing additional clarification of TMC evaluation expectations relative to the *differences* between the classes.

Introduction

NASA has opened the door to a wide array of innovative designs including instruments and CubeSats ranging between payload risk Class C and D. There are clear differences in the design and development of a Class C and Class D payload.

This document was created to provide clarification to proposers regarding the expectations TMC evaluators have regarding Class D and C payloads.

These expectations are in no way intended to be a comprehensive checklist regarding evaluating Class C and D (including CubeSat) proposals, and are intended to be supplementary and educational with the goal of assisting the proposers.

This document is planned to continually be updated with the Lessons Learned from applicable TMC evaluations.

Background

NASA uses the Second Stand Alone Missions of Opportunity Notice (SALMON-2) Announcement of Opportunity (AO) and its associated Program Element Appendices (PEAs) to solicit proposals for Earth and space sciences. NASA establishes the expected risk posture of these proposals by defining their payload risk classification. For the purpose of the evaluation, CubeSats are considered Class D with some unique requirements. CubeSats are not precluded from proposing beyond the expectations of Class D as long as the cost cap is not exceeded. NASA Procedural Requirement (NPR) 8705.4 describes Classes A-D and suggests approaches to safety and mission assurance (S&MA) requirements for each class.

The proposing community wants to know the expectations from a Pre-Phase A proposal's description of its approach to formulation and implementation. This document addresses this question, but includes two considerations for interpreting this guidance:

- First, a project's development approach is usually not fully defined until Phase B (see NPR 7123.1B), so both the details and expectations are fluid.

- Second, the requirements and evaluation factors of the proposed development approach are described in the PEA and SALMON-2 AO. Therefore the following list of factors should not be interpreted as a compliance matrix or as being comprehensive, but only as elaboration of the guidance provided by NASA including the guidance from NPR 8705.4 and LSP-REQ-317.01B.

TMC Panel Expectations

Applicable to all Classes

The TMC panel expects compliance with the requirements in the SALMON-2 AO and the associated PEA. Project teams may propose streamlined development efforts, for example fewer life-cycle reviews, but the TMC panel still expects acknowledgement of NPR 7120.5E, and **rationale** for how they plan to tailor the standard approach and their intent to submit any necessary waivers.

Proposals are expected to describe a formulation and implementation plan that is both adequate and robust ***for the specified payload risk classification***. It is also expected that these proposals demonstrate that their team understands the integrated processes, products, requirements and activities to successfully develop and integrate the mission.

Similarly, the proposals are expected to demonstrate that the plans for management, cost, systems engineering, mission assurance and verification are adequate and robust for ***the specified payload risk classification*.**

TMC Panel Expectations

Applicable to Class D

A Class D payload is medium to low complexity, short project lifetime (generally less than 2 years), of low to medium priority, carrying medium to high performance risk. Class D payloads may exercise freedom to tailor the suggested procedures and guidelines to optimize or streamline the formulation and implementation approach to control costs as long as the tailoring is appropriately justified. This tailoring is intended to limit the activity to only the guidelines, specifications and standards necessary to meet mission requirements. In comparison to Class C, the Principal Investigator and Project Manager have a larger degree of freedom to define resource needs, define the project plan, and lead the project's execution.

The TMC panel will expect a sound basis for the cost estimate, particularly in cases where there are few or no heritage payloads in the class being proposed.

In cases where a Class D instrument is proposed to fly on a higher priority mission of NASA or another agency or commercial vendor, the proposal must pay particular attention to the issues of risk to the host spacecraft or surrounding instruments. If the proposer identifies a specific host, the TMC panel will expect the proposal to demonstrate compliance with the risk requirements of that host.

TMC Panel Expectations

Document Precedence

The set of expectations contained in this document are in no way intended to supersede the requirements of the AO. In the event of a conflict between expectations described here, the AO takes precedence.

Note

For Small Category 3, Class D projects with a life-cycle cost of under $150 million, proposers should refer to guidance on tailoring NPR 7120.5 requirements from the NASA AA, which can be found on the OCE tab in NODIS under "Other Policy Documents" at http://nodis3.gsfc.nasa.gov/OCE_docs/OCE_25.pdf

Introduction to NPR 8705.4

NPR 8705.4 is a set of Class C and D guidelines referenced by the solicitation that are intended to apply across the entire life-cycle of a program, and are intended to be addressed at various stages of program maturity. Many of the guidelines in NPR 8705.4 and its Appendix B are intended to be addressed at later stages of a project and not at proposal writing. However NPR 8705.4 Appendix C contain guidelines that are expected to be addressed within the proposal.

The following slides extract each Appendix C guideline from NPR 8705.4, shown at the top of each slide, followed by a set of TMC panel expectations for Class C and Class D payloads below. The following slides are presented in the same sequence as shown in NPR 8705.4. Note that this sequence does not imply priority.

If tailoring of the following guidelines is proposed, the TMC panel expects the proposer to include a description of the tailoring and appropriate rationale relative to the proposed payload risk classification (C or D).

.

Single Point Failures

NPR 8705.4 Appendix C

TMC Expectations for Class C/D

Characterization	Class C	Class D
Single Point Failures	Critical SPF's (for Level 1 requirements) may be permitted but are mitigated by use of high reliability parts, additional testing, or by other means. Single string and selectively redundant design approaches may be used.	Same as Class C

Class C TMC Expectations	Class D TMC Expectations
Critical (for level 1 requirements) Single Point Failures (SPFs) should be identified. Credible mitigation plans for all critical SPFs should be discussed. Some examples of viable mitigation plans can include: additional life testing, higher quality parts, parts screening, and/or trades for functional redundancy.	Same as Class C

EM, Prototype, Flight

NPR 8705.4 Appendix C

Characterization	Class C	Class D
Engineering Model, Prototype, Flight, and Spare Hardware	Engineering model hardware for new designs. Protoflight hardware permitted (in lieu of separate prototype and flight models). Limited flight spare hardware (for long lead flight units).	Limited engineering model and flight spare hardware

Class C TMC Expectations	Class D TMC Expectations
The approach to prototype, engineering, and flight or protoflight hardware is expected to be described and justified.	The approach to prototype, engineering, and flight or protoflight hardware is expected to be described and justified. This requirement can be interpreted liberally, to include testing on the flight unit only. The approach could include limited or no Engineering Model hardware (with appropriate rationale provided by the proposer).

Spares

NPR 8705.4 Appendix C

Characterization	Class C	Class D
Engineering Model, Prototype, Flight, and Spare Hardware	Engineering model hardware for new designs. Protoflight hardware permitted (in lieu of separate prototype and flight models). Limited flight spare hardware (for long lead flight units).	Limited engineering model and flight spare hardware

Class C TMC Expectations	Class D TMC Expectations
Hardware spares are expected for components that are relatively unique or very difficult to replace and are critical to mission success (e.g., screened parts, newly developed detectors, test-sensitive components, unique avionics boards, etc.). The Master Equipment List should document the number or lack of any spares. Hardware spares are expected for critical items for Class C.	A description and rationale of the approach to hardware spares is expected. The Master Equipment List should document the number of any spares planned including "0" if none are proposed.

Qualification, Acceptance, Protoflight

NPR 8705.4 Appendix C

TMC Expectations for Class C/D

Characterization	Class C	Class D
Qualification, Acceptance, and Protoflight Test Program	Limited qualification testing for new aspects of the design plus full acceptance test program. Testing required for verification of safety compliance and interface compatibility	Testing required only for verification of safety compliance and interface compatibility. Acceptance test program for critical performance

Class C TMC Expectations	Class D TMC Expectations
Qualification level testing of new hardware designs is expected. Full acceptance testing is expected for all requirements. Safety and interface compliance are also expected to be verified by test. If the ISS is identified as candidate host, it is expected that the test plan will be consistent with ISS guidelines.	Safety and interface compliance are expected to be verified by test. Acceptance for critical performance is expected to be verified by test. Not all details of the test program need to be provided in a pre-Phase A proposal, but a test plan description should be provided. In some cases qualification by analysis, inspection and/or demonstration, rather than hardware testing may be acceptable if properly justified. If the ISS is identified as candidate host, it is expected that the test plan will be consistent with ISS guidelines Note: in the case of CubeSats, adherence to the requirements in LSP-REQ-317.01A is expected.

EEE parts

NPR 8705.4 Appendix C

Characterization	Class C	Class D
EEE parts http://nepp.nasa.gov/npsl	Class A, Class B or NPSL* Level 3, Level 3 equivalent SCDs*, and/or requirements per Center Parts Management Plan	Class A, Class B, or Class C requirements and/or requirements per Center Parts Management Plan.

Class C TMC Expectations	Class D TMC Expectations
The TMC panel expects to see a description of the approach to parts screening with rationale, and to demonstrate an understanding of the parts screening process. A description of the parts plan is expected.	The TMC panel expects to see a description of the approach to parts screening with rationale, and to demonstrate an understanding of the parts screening process, including the impacts of using COTS* components.

* NPSL (NASA Parts Selection List), SCD (Source Control Drawing), COTS (Commercial Off-The-Shelf)

Reviews

NPR 8705.4 Appendix C

Characterization	Class C	Class D
Reviews	Full formal review program. Independent reviews managed at Center level with Mission Directorate participation. Include formal inspection of software requirements, peer reviews of design and code.	Center level reviews with participation of all applicable directorates. May be delegated to Projects. Peer reviews of software requirements and code.

Class C TMC Expectations	Class D TMC Expectations
All program and life-cycle reviews required by NPR 7120.5E are expected to be addressed.	Program and life-cycle reviews required by NPR 7120.5E are expected to be addressed. A rationale is expected if any NPR 7120.5E reviews are combined or eliminated. If additional streamlining is proposed, the TMC panel expects the proposal to contain a description of the differences and rationale for tailoring.

Safety

NPR 8705.4 Appendix C

Characterization	Class C	Class D
Safety	Per all applicable NASA safety directives and standards	Per all applicable NASA safety directives and standards

Class C TMC Expectations	Class D TMC Expectations
Per NASA Safety Standards	Per NASA Safety Standards. For Class D, safety and mission assurance planning is expected to be tailored to be commensurate with cost constraints, schedule, and NASA requirements. The scope of safety and mission assurance is expected to focus on "do no harm" to surrounding payloads or the on-orbit spacecraft. Note: For CubeSats, additional safety standards are included in the LSP-REQ-317.01B document.

Materials

NPR 8705.4 Appendix C

Characterization	Class C	Class D
Materials	Use previously tested/flown materials or characterize new materials. Acceptance test sample lots of procured materials.	Requirements are based on applicable safety standards. Materials should be assessed for application and life limits.

Class C TMC Expectations	Class D TMC Expectations
No discussions are expected.	

Reliability

NPR 8705.4 Appendix C

Characterization	Class C	Class D
Reliability NPD 8720.1	FMEA/CIL* scope determined at the project level. Analysis of interfaces. Parts electrical stress analysis for all parts and circuits	Analysis requirements based on applicable safety requirements. Analysis of interface.

Class C TMC Expectations	Class D TMC Expectations
No reliability analysis or results are expected to be shown in the proposal.	

* FMEA (Failure Modes and Effects Analysis), CIL (Critical Items List)

Fault Tree Analysis

NPR 8705.4 Appendix C

Characterization	Class C	Class D
Fault tree Analysis	System level qualitative fault tree analysis	Fault tree analysis required for safety critical functions

Class C TMC Expectations	Class D TMC Expectations
No fault tree analysis or results are expected to be shown in the proposal.	

Probabilistic Risk Assessment

NPR 8705.4 Appendix C

Characterization	Class C	Class D
Probabilistic Risk Assessment (PRA) NPR 8705.5	Simplified, indentifying major mission risk contributors. Other discretionary applications	Safety only. Other discretionary applications

Class C TMC Expectations	Class D TMC Expectations
No PRA or results are expected to be shown in the proposal. However, this guidance does not supersede the requirements for risk management expectations as described in the AO.	

Maintainability

NPR 8705.4 Appendix C

TMC Expectations for Class C/D

Characterization	Class C	Class D
Maintainability[1] NPD 8720.1	Maintainability considered during design if applicable	Requirements based on applicable safety standards.

Note 1: For ISS payloads, maintainability, reliability, and availability requirements should be defined at an early phase and plans addressed during the design, development, and testing of the payload, regardless of class. Components with low reliability should be assessed for on-orbit maintainability based on the availability requirements, and other relevant factors. The balance of these factors should result in a payload that meets performance requirements for the required duration of flight.

Class C TMC Expectations	Class D TMC Expectations
Maintainability is not expected to be described in the proposal.	

Quality Assurance

NPR 8705.4 Appendix C

Characterization	Class C	Class D
Quality Assurance NPD 8730.5, NPR 8735.2 (NPR 8735.1)	Formal quality assurance program including closed-loop problem reporting and corrective action, configuration management, tailored surveillance. GIDEP failure experience data and NASA advisory process	Closed-loop problem reporting and corrective action , configuration management, GIDEP failure experience data and NASA advisory process. Other requirements based on applicable safety standards.

Class C TMC Expectations	Class D TMC Expectations
The TMC panel expects a description of a closed loop problem reporting system and a plan to monitor GIDEP alerts. The TMC panel also expects the proposer to include a brief description of the intent to implement a responsive quality assurance program, Configuration Management, manufacturing and test surveillance.	The TMC panel expects a summary description of the proposer's plans for mission assurance, including any proposed tailoring, with rationale.

Software

NPR 8705.4 Appendix C

Characterization	Class C	Class D
Software	Formal project software assurance insight. IV&V as determined by AA OSMA	Formal project software assurance insight.

Class C TMC Expectations	Class D TMC Expectations
The TMC panel expects a short description of the software development and test process including operations. The TMC panel also expects to see a description of the software heritage. The TMC panel expects the proposer to demonstrate compliance with "Class C" software per NPR 7150.2A. Note that the software class is independent of the mission reliability class. The TMC panel also expects the proposer to include a short description of the flight software quality assurance approach, which is expected to comply with NPR 7120.5E, which refers to NPR 7150.2A. A rationale is expected for any deviations from NPR 7150.2A.	The TMC panel expects a short description of the software development and test process. The TMC panel also expects to see a description of the software heritage.

Telemetry Coverage and Critical Events

NPR 8705.4 Appendix C

Characterization	Class C	Class D
Telemetry Coverage[2] for Mission-Critical Events	During all mission critical events to assure data is available for critical anomaly investigations to prevent future recurrence.	Same as Class C

Note 2: Mission critical events in the operation of a spacecraft are those which, if not executed successfully (or recovered from quickly in the event of a problem), can lead to loss or significant degradation of mission. Included in critical event planning are timelines allowing for problem identification, generation of recovery commands, and up linking in a timely manner to minimize risk to the in-space assets. Examples include separation from a launch vehicle, critical propulsion events, deployment of appendages necessary for communication or power generation, stabilization into propulsion events, stabilization into a controlled power positive attitude, and entry-descent and landing sequences.

Class C TMC Expectations	Class D TMC Expectations
All classes must comply with the critical event requirements as described in the AO	

Concluding Remarks

NASA has opened the door to a wide array of innovative designs including full missions, missions of opportunity, and instruments with Class D payload risk classification. There are clear differences in the design and development of a Class C and Class D payload.

This document was created to provide clarification to proposers regarding the expectations TMC evaluators have regarding Class C and Class D payloads.

These expectations are in no way intended to be a comprehensive checklist regarding evaluating Class C and Class D (including CubeSat) proposals, and are intended to be supplementary and educational with the goal of assisting the proposers.

This document is planned to continually be updated with the Lessons Learned from applicable TMC evaluations.